Quarterly Report – Public Page

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Contract Number: DTPH56-06-T-000020

Prepared for: DOT/PHMSA and GTI SMP (Sustaining Membership Program)

Project Title: Phase Sensitive Methods to Detect Cathodic Disbondment

Prepared by: Gas Technology Institute

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Objective and Public Abstract

The proposed work is to develop a phase sensitive technology that could detect coating disbondment on steel pipe from above ground, thus locating potential corrosion failure points. The system would consist of two components, a stationary signal generator that is attached to a test point and a detector that is carried along the pipeline. Sinusoidal or pulse excitation signals may be used. A wireless link between the generator and the detector provides accurate synchronization. An abrupt change of signal phase is expected at the disbondment.

There is currently no method to detect or locate a disbonded coating from above ground. Existing pipeline potential gradient surveys, both DC and AC voltage, make use of only amplitude data. While amplitude methods can detect an active holiday (break) in the coating, a disbonded coating can shield active corrosion from both detection and cathodic protection. Stated another way, the space between a disbonded coating and the pipe can house an active corrosion cell. Until there is an actual holiday in the coating, the corrosion cell cannot be detected with current technology. A holiday will allow increased cathodic protection current to flow to the pipe in the immediate vicinity of the holiday, but may not reach the extremities of a large disbondment.

A disbonded coating can contain an active corrosion cell that is undetectable until serious damage has occurred to the pipe wall. There is no exterior method that can reliably detect disbonded coating at this time. The coating effectively "shields" areas of active corrosion within the disbondment from DC or AC voltage gradient surveys. Internal methods, such as magnetic flux leakage (MFL) pigging may detect wall thinning but will not differentiate causes. MFL pigging is expensive and may not be possible on lines with

bends or diameter changes. The proposed work is to provide a completely new method for surveying pipelines.

The object of the proposed work is to develop a technology that could detect coating disbondment on steel pipe from above ground, thus identifying potential corrosion locations before the pipeline fails. The deliverable would be prototypes of two components, a stationary signal generator and a hand carried detector. The signal generator would be attached to the pipeline at a test station. The hand-held device would be carried along the pipeline to acquire signal phase and amplitude measurements from the pipeline.

Team Project Activities as outlined in OTA

Task 1 - Parametric Studies

- Catalog the most common pipe and coating materials
- Identify a reasonable subset of these to use experimentally
- Form a Project Advisory Committee from SMP and DOT to review findings (1)
- Get consensus on minimum size of disbondment that needs to be found
- Get agreement on the pipe and coating sub-set from the members
- Identify one utility test site that fits within the set
- Prepare formal Experimental Test Plan and get Advisors approval (3)
- Using transmission line theory, estimate the phase shift per foot of pristine pipe
- Estimate the additional phase shift created by a disbondment
- Obtain soil impedance data with emphasis on test site area
- Calculate theoretical minimum size of disbondment that is detectable

Task 2 - Prepare Representative Disbondment Samples

- Obtain samples of coated pipe within the test set
- Examine the samples with laboratory grade impedance analyzer
- Determine if there are any existing coating disbondment in the samples
- Create intentional disbondment of know geometry on several pipe samples (4)
- Measure the impedance of the disbondment specimens in a water bath
- Bury a set of disbondment specimens and a pristine pipe in representative soil
- Measure the characteristic impedance of the pipes in soil using analyzer (6)
- Perform time domain reflectometry on buried pipe samples
- Provide detailed document of GTI test area to Advisors

Task 3 - Construct a Breadboard Instrument

- Choose excitation signal based on in soil measurements
- Construct and test signal injection generator (8)
- Construct and test hand-held phase detection apparatus (10)
- Verify that wireless link between these two is functioning (12)
- Document the construction details of breadboard as built

Task 4 - Test the Breadboard Instrument

- Using the samples prepared and installed at GTI pipe farm during Task 2
  - Verify breadboard can measure the phase shift of pristine pipe
  - Test breadboard over various fabricated disbondment samples
- Based on pipe farm tests make improvements to breadboard (14)
- Repeat the pipe farm tests to verify improvements
- Test the breadboard disbondment detector on a utility site (16)

Task 5 - Project Management

- Submit state of the art assessment to PHMSA within 30 days of contract signing
- Submit a Experimental Test Plan with the pipes, coatings, and size of disbondments agreed on by the advisors group to both the SMP and PHMSA
- Provide quarterly reports to PHMSA and Advisors (2,5,7,9,11,13,15)
- Submit draft of Final Report for comment (17)
- Address comments and complete Final Report (18)
- Presentation of one technical paper at a public forum (19)
- Attendance of two annual peer review meetings in Washington DC. (20)

Note that the item numbers (#) correspond to those in "Technical and Deliverable Milestone Schedule."

Progress to Date

The following was accomplished this quarter:

Task 1 - Parametric Studies: An advisory group was formed from members of GTI's Sustaining Membership Program (SMP) Technical Guidance Committee (TGC.) The group was sent a survey form with the following questions:

1. How many miles of coated steel pipe are in your system?
2. How many new miles of coated steel are installed every year?
3. What type of coated steel do you have the most of?
4. What type of coated steel has the most failures?
5. How is your steel cathodically protected?
6. Would your company be interested in hosting a test?
7. Does your company have conventional surveys of coated steel pipelines scheduled in the next two years?

Task 5 - Project Management: A state of art assessment document was drafted and circulated to the advisory group. The introduction portion of the SOA is shown below:

This document serves as a state of the art for technologies used to detect cathodic disbondment on steel pipe. The object of the proposed work is to develop a technology that could detect coating disbondment on steel pipe from above ground, thus identifying

potential corrosion locations before the pipeline fails. There is currently no method to detect or locate a disbonded coating from above ground. Existing pipeline potential gradient surveys, both DC and AC voltage, make use of only amplitude data. While amplitude methods can detect an active holiday (break) in the coating, a disbonded coating can shield active corrosion from both detection and cathodic protection. Stated another way, the space between a disbonded coating and the pipe can house an active corrosion cell. Until there is an actual holiday in the coating, the corrosion cell cannot be detected with current technology. A holiday will allow increased cathodic protection current to flow to the pipe in the immediate vicinity of the holiday, but may not reach the extremities of a large disbondment. Internal methods, such as magnetic flux leakage (MFL) pigging may detect wall thinning but will not differentiate causes. MFL pigging is expensive and may not be possible on lines with bends or diameter changes.

A patent research was performed, and no technologies relating to Phase Sensitive Methods to Detect Cathodic Disbondment were found. There are, however, other technologies that detect cathodic disbondment by other means.

Please contact GTI or DOT if the full state of art assessment is requested. If mutually agreed upon by GTI, DOT, and SMP, the assessment will be distributed.

Point of contact for coordination, preparation, and distribution of any press releases:

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